

SUPPORT FOR THE AMENDMENT

This Amendment amends Claims 11 and 48; and adds new Claims 51-57. Support for the amendments is found in the specification and claims as originally filed. In particular, support for Claim 11 is found in the specification at least at Table 3, Steel O ("0.62" mass % Cr). Support for Claim 48 is found in the specification at least at page 6, lines 24-25. Support for new Claim 51 is found in Claim 49. Support for new Claims 52-53 is found in Claim 11. Support for new Claim 54 is found in the specification at least at page 4, lines 9-10. Support for new Claim 55 is found in the specification at least at page 4, lines 17-18. Support for new Claim 56 is found in the specification at least at page 4, lines 25-26. Support for new Claim 57 is found in the specification at least at page 4, line 33 to page 5, line 1. No new matter would be introduced by entry of these amendments.

Upon entry of these amendments, Claims 11-14, 43-46 and 48-57 will be pending in this application. Claim 11 is independent.

REQUEST FOR RECONSIDERATION

Applicants respectfully request entry of the foregoing and reexamination and reconsideration of the application, as amended, in light of the remarks that follow.

The present invention provides a hard-drawn steel wire allowing springs made of the wire to exhibit excellent fatigue strength and sag resistance even without subjecting a drawn wire to quenching and tempering treatments. Specification at page 1, lines 7-9. The hard-drawn wire consists of ferrite and/or pearlite; contains C in an amount of 0.5 - 0.68 mass%, Si in an amount of 1.2 - 1.95 mass% and Cr in an amount of 0.62 - 1.5%; and comprises 5 particles/100 μm^2 or less of carbides wherein the circle-equivalent diameters of the carbides are more than 0.1 μm . The C content of 0.68 mass% or less inhibits fracture in performing works and the occurrence of cracks that deteriorate fatigue life. Specification at page 4, lines

4-6. The Si content enhances sag resistance, without degrading fatigue strength.

Specification at page 4, lines 11-18. The limited number of large carbides in the hard-drawn wire, which consists of ferrite and/or pearlite, provides improved fatigue strength and sag resistance equal or superior to that of an oil-tempered wire consisting of tempered martensite generated by the quenching and tempering treatment. Specification at page 2, lines 13-16; page 3, lines 15-25.

Claims 11-14, 43-46 and 48-50 are rejected under 35 U.S.C. §103(a) over Japanese Patent No. 7-90495 ("JP-495") in view of U.S. Patent No. 6,645,319 ("Nagao") or Japanese Patent No. 8-120407 ("JP-407").

JP-495 discloses a steel wire containing 0.7-1.0 wt% C, 1.0 wt% or less of Si, 0.5% or less of Cr, and 0.05-1.0 vol% of carbide of V or Nb having a size of 0.1 μm or less. English-language abstract of JP-495. JP-495 discloses that C less than 0.7 wt% causes deterioration of strength (JP-495 at column 2, line 40) and the size of carbide of V or Nb more than 0.1 μm impairs workability (JP-495 at column 3, lines 10-11).

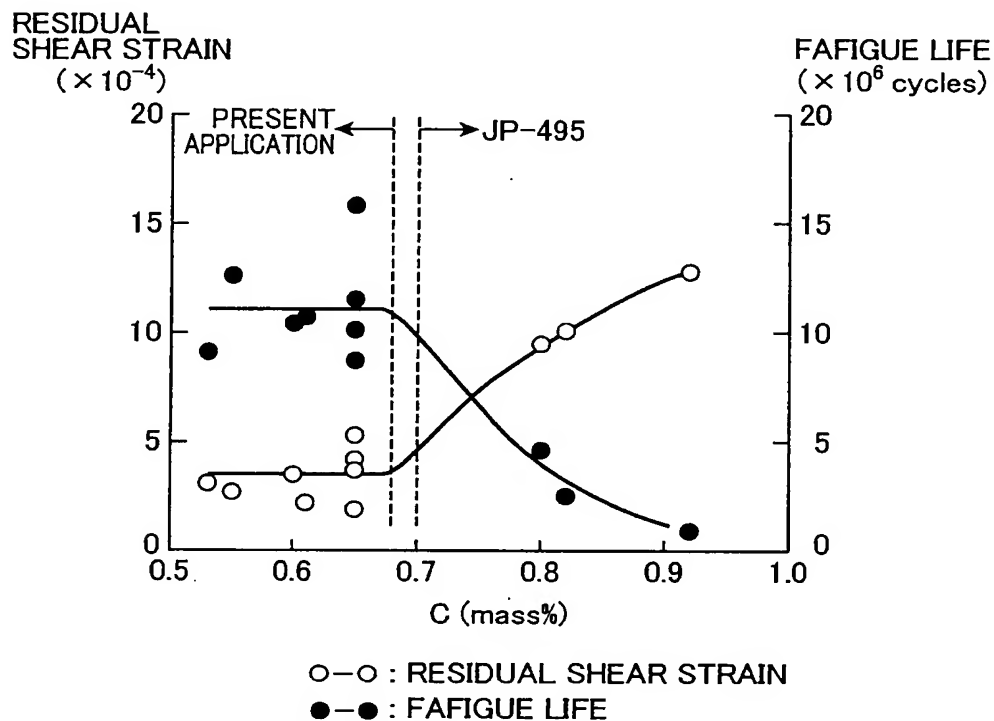
However, JP-495 fails to suggest the independent Claim 11 limitations of a "hard-drawn steel wire comprising: C: 0.5 - 0.68 mass% ..., Si: 1.2-1.95%, ..., Cr: 0.62 -1.5%, ..., wherein ... said wire further comprises 5 particles/100 μm^2 or less of carbides wherein the circle-equivalent diameters of the carbides are more than 0.1 μm ".

Nagao discloses a wire rod for drawing that contains C: 0.65-1.2 mass% and Si: 0.1-2.0 mass%. Nagao at abstract, column 3, lines 46 and 62. Nagao discloses that the Si functions as a deoxidizer. Nagao at column 3, line 63.

JP-407 discloses steel wire, having high strength, high toughness and high ductility, that is essentially composed of one or more structures selected from the group consisting of fine pearlite, pseudo-pearlite, and bainite. JP-407 also discloses that the average grain size of carbides in the structures is regulated to 10-50 nm. JP-407 at English-language abstract.

Any *prima facie* case of obviousness based on the cited prior art is rebutted by the significant improvement in the combination of fatigue strength and sag resistance that is achieved by the present invention in accordance with independent Claim 11 with a "hard-drawn steel wire comprising: C: 0.5 - 0.68 mass% ..., Si: 1.2-1.95%, ..., Cr: 0.62 -1.5%, ..., wherein ... said wire further comprises 5 particles/100 μm^2 or less of carbides wherein the circle-equivalent diameters of the carbides are more than 0.1 μm ".

The Figure below shows a relationship between C content in the wire (horizontal axis) and residual shear strain (left vertical axis) or fatigue life (right vertical axis), in which the C contents of the Steels A to K of Table 1 in the specification (excluding the C content of Steel H, which is less than 0.5%) are plotted relative to the residual shear strain data or fatigue life data for wire Nos. 1 to 7, 9 to 11, 14 and 15 of Table 2 in the specification (excluding wire Nos. 8 and 13 having a number of carbides of more than 5 particles/100 μm^2).



The "residual shear strain" is used as an index of sag resistance (a smaller residual shear strain means a better sag resistance). The "fatigue life" is a measure of fatigue strength (a higher fatigue life means a better fatigue strength). Specification at page 12, lines 14-17.

The Figure above shows that the fatigue life is sharply reduced and concurrently the residual shear strain is sharply increased (sag resistance is lowered) outside of the independent Claim 11 range of "C: 0.5 - 0.68 mass%".

In addition, as shown in the above Figure, wire Nos. 9, 10 and 11 having C contents of more than 0.68% exhibit reduced fatigue life and increased residual shear strain, even though the number of carbides in the wires were 5 particles/100 μm^2 or less. Further, wire Nos. 8 and 13 (not shown in the Figure) having numbers of carbides of more than 5 particles/100 μm^2 exhibit reduced fatigue life and increased residual shear strain, even though the C contents in the wires were 0.68% or less. Thus, if either the C content or the number of carbides more than 0.1 μm is outside the ranges defined by Claim 11, then improvements in fatigue strength and sag resistance are not observed.

The cited prior art fails to suggest the significant improvement in the combination of fatigue strength and sag resistance that is achieved by the present invention in accordance with independent Claim 11 with a "hard-drawn steel wire comprising: C: 0.5 - 0.68 mass% ..., Si: 1.2-1.95%, ..., Cr: 0.62 -1.5%, ..., wherein ... said wire further comprises 5 particles/100 μm^2 or less of carbides wherein the circle-equivalent diameters of the carbides are more than 0.1 μm ". Thus, any *prima facie* case of obviousness based on the cited prior art is rebutted.

Note that the wire of JP-495 contains 1.0% or less Si and 0.5% or less Cr (cf. [0009]). In JP-495, a ratio (Si/C) of Si (1.0% or less) to C (0.7 to 1.0%) is calculated to be 1.0/0.7 or less, namely 1.4 or less. In a similar way, a ratio (Cr/C) of Cr (0.5% or less) to C (0.7 to 1.0%) is calculated to be 0.5/0.7 or less, namely 0.7 or less.

In contrast, the wire of the present invention contains "Si: 1.2-1.95%" and "Cr: 0.62-1.5%", both outside the ranges of JP-495. Further, the ratio (Si/C) of Si (1.2 to 1.95%) to C (0.5 to 0.68%) is calculated to be 1.2/0.68 or more and 1.95/0.5 or less, namely 1.8 or more. In a similar way, the ratio (Cr/C) of Cr (0.62 to 1.5%) to C (0.5 to 0.68%) is calculated to be 0.62/0.68 or more and 1.5/0.5 or less, namely 0.9 or more.

Therefore, there exists a gap between JP-495 and the present invention in terms of Si/C (1.4 or less vs. 1.8 or more) and Cr/C (0.7 or less vs. 0.9 or more). Since the C contents as the denominator has the critical feature as shown above, these gaps in terms of Si/C and Cr/C show that the significant improvements in fatigue strength and sag resistance achieved by independent Claim 11 is not the result of routine optimization.

Furthermore, as shown in the above Figure, even though the number of carbide particles is 0/100 μm^2 , wire Nos. 9, 10 and 11 having C contents of 0.8 to 0.92% show reduced fatigue life and increased residual shear strain (cf. Tables 1 and 2). Namely, even if carbides in the wire of JP-495 are modified so that the number of the carbide particles is 0/100 μm^2 , such modification would not yield satisfactory effects on fatigue strength and sag resistance, since the carbon content of JP-495 is in the range of 0.7 to 1.0%.

Moreover, Nagao discloses a wire containing 0.65 to 1.2% C (cf. column 3, line 46). On the other hand, JP-495 discloses that C content less than 0.7% causes deterioration in strength of a wire (cf. [0009]). If the C content is lowered to the range of the present invention (0.68% or less) by combining the C content of Nagao with JP-495, then the strength of the wire of JP-495 would deteriorate. Thus, such a combination is prohibited.

In addition, since carbides in JP-407 exist in a form of cementite crystal grain in a lamellae cementite (cf. [0013]), such carbides of JP-407 cannot be combined with those of JP-495 in which carbides precipitating in a cementite are not involved (cf. [0010]). In addition, the carbides of the present invention do not include any cementite phase (cf. specification at page 3, lines 26-27).

Because any *prima facie* case of obviousness based on the cited prior art is rebutted, the rejection under 35 U.S.C. § 103(a) should be withdrawn.

Pursuant to MPEP 821.04(b), after independent product Claim 11 is allowed, Applicants respectfully request examination and allowance of method Claims 48 and 51, which include all of the limitations of product Claim 11.

In view of the foregoing amendments and remarks, Applicants respectfully submit that the application is in condition for allowance. Applicants respectfully request favorable consideration and prompt allowance of the application.

Should the Examiner believe that anything further is necessary in order to place the application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned attorney at the telephone number listed below.

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